Engineering Educators Bringing the World Together
2025 ASEE Annual Conference & Exposition
Palais des congrès de Montréal, Montréal, QC • June 22–25, 2025 ASEE
Paper ID #46241

BOARD # 473: YEAR TWO: The Organizational Climate Challenge: Promoting the Retention of Students from Underrepresented Groups in Doctoral Engineering Programs (NSF 21-588: EDU Core Research)

Dr. Julie L. Aldridge, The Ohio State University

My background and research interests include developing evidence-based tools to guide the implementation and assessment of organizational change efforts directed at policies, practices, and procedures. My strengths are ideation and transdisciplinary teamwork. My current work combines organizational climate science with an intersectional approach to better support the retention of engineering doctoral students from diverse groups to degree completion.

Nicole M. Else-Quest, University of California, Los Angeles

Nicole M. Else-Quest is Professor of Education at the University of California, Los Angeles. A first-generation college student, Dr. Else-Quest earned her Ph.D. in developmental psychology at the University of Wisconsin—Madison. She uses a combination of quantitative and qualitative methods to understand psychological gender differences, how they develop and shape participation in STEM, and how we can intervene to expand women's and girl's participation in STEM. She has written extensively on implementing intersectionality within social sciences research and adapting quantitative as well as qualitative methods to do so. Else-Quest is currently PI on two grants from the National Science Foundation, both focused on developing and implementing interventions to improve girls' and women's participation and persistence in STEM education from elementary school through doctoral training. In addition to her scholarly work, she is author of the undergraduate textbook, Psychology of Women and Gender: Half the Human Experience+ (Sage, 2025). She is a Fellow of the American Psychological Association.

Dr. So Yoon Yoon, University of Cincinnati

Dr. So Yoon Yoon is an assistant professor in the Department of Engineering and Computing Education in the College of Engineering and Applied Science at the University of Cincinnati, OH, USA. Dr. Yoon received her Ph.D. in Gifted Education, and an M.S.Ed. in Research Methods and Measurement with a specialization in Educational Psychology, both from Purdue University, IN, USA. She also holds an M.S. in Astronomy and Astrophysics and a B.S. in Astronomy and Meteorology from Kyungpook National University, South Korea. Her work centers on elementary, secondary, and postsecondary engineering education research as a psychometrician, data analyst, and program evaluator with research interests in spatial ability, STEAM education, workplace climate, and research synthesis with a particular focus on meta-analysis. She has developed, validated, revised, and copyrighted several instruments beneficial for STEM education research and practice. Dr. Yoon has authored more than 85 peer-reviewed journal articles and conference proceedings and served as a journal reviewer in engineering education, STEM education, and educational psychology. She has also served as a PI, co-PI, advisory board member, or external evaluator on several NSF- and NASA-funded projects.

Dr. Joe Roy, American Society for Engineering Education

Joseph Roy has over 15 years of data science and higher education expertise. He currently directs three national annual data collections at the ASEE of colleges of engineering and engineering technology that gather detailed enrollment, degrees awarded, research expenditures, faculty headcounts, faculty salary and retention data for the engineering community. He is PI of a NSF Advanced Technological Education funded grant to build a national data collection for engineering-oriented technician degree and certificate programs at 2-year institutions. Prior to joining the ASEE, he was the senior researcher at the American Association of University Professor and directed their national Faculty Salary Survey. He also developed a technical curriculum to train analysts for a national survey of languages in Ecuador while he was at the University of Illinois as a linguistic data analytics manager and member of their graduate faculty. He has a B.S. in Computer Science & Mathematics, a M.S. in Statistics from the University of Texas at San Antonio and a Ph.D. in Linguistics from the University of Ottawa.

Year Two: The Organizational Climate Challenge:
Promoting the Retention of Students from Underrepresented Groups
in Doctoral Engineering Programs -EDU Core Research

I. Introduction

The goal of this 4-year project is to develop and validate a multi-factor organizational climate survey tailored to assess perceptions of department-level policies, practices, and procedures influencing engineering doctoral student retention and commitment to degree completion. This project adopts an explicitly intersectional approach to the meaning and relevance of students belonging to multiple social categories, including gender, race/ethnicity, and sexual orientation, considered within the context of engineering doctoral education. Our project uses a student-centered approach to shed light on the specific organizational climate in doctoral engineering departments by engaging with students from diverse groups. We draw on organizational climate research and intersectionality theory to answer three research questions: 1. What focused climates are present in doctoral engineering departments? 2. How do climate perceptions differ by intersecting social categories? 3. How do climate perceptions relate to organizational commitment to degree completion?

We combined an intersectional, student-centered approach to organizational climate to identify specific focused climates relevant to doctoral engineering student retention. The American Council on Education [1] has delineated a need for academic leaders to develop policies and best practices to promote diversity in STEM. Although findings from climate studies grounded in organizational science have practical applications and can guide specific policies, practices, and behaviors, "climate" research in higher education is siloed from organizational climate advances. Starting with Hall and Sandler [2], a meteorological metaphor of climate has been used for decades to explain educational disparities, with research on improving diversity outcomes in higher education organizations pointing to a negative or "chilly" atmosphere that results in lower retention rates to degree completion.

Since the 1980s, research on "campus climate" has become commonplace in higher education (e.g., Hurtado et al., 1998; Nightingale, 2022; Parker & Trolian, 2020; Worthington et al., 2008). However, the research findings are so vague that their utility and meaning are limited [3]. The result is that higher education climate research has had limited success in increasing the number of engineering doctorates obtained by women and people from other historically-excluded groups. In 2022, women earned 26.2% of the engineering doctoral degrees awarded in the U.S., with fewer than half of those women being U.S. residents. Of those degrees, American Indian women earned 0.1%, Black women earned 5.0%, multiracial women earned 5.3%, Latina women earned 9.7%, Asian American women earned 18.5%, and white women earned 61.3% [4]. Likewise, Black, Latina, and Native American women continue to face longer time-to-degree completion and a greater risk of attrition than their male counterparts [5].

II. Work to Date

We published a literature review [6] as a preliminary assessment of the available research literature produced by the engineering education community on climate affecting the persistence or retention of engineering doctoral students from diverse backgrounds. We sought to understand doctoral student retention as an organizational climate issue. We used an intersectional approach to consider the meaning and relevance of students' belonging simultaneously to multiple social categories, such as gender identity, sexual orientation, socioeconomic background, race/ethnicity, and disability status, within the context of engineering doctoral education as a first step to building a climate survey instrument. Our narrative review demonstrated that 1) climates are rarely directly discussed within the engineering education community, and 2) when there are climate studies, constructs are ill-defined or derived from literature outside organizational climate theory. Moreover, because those studies use survey instruments that are not validated for the climate constructs they claim to measure or for assessment across multiple intersectional groups of students, it is difficult to draw reliable conclusions from them or translate their results to inform policy or practice meaningfully.

We conducted a meta-synthesis [7] of climate in engineering doctoral programs. We created a framework of focused climates from organizational climate literature found to be associated with member retention or organizational commitment, including some pertaining specifically to diversity. We searched papers for indications of the climates in our framework and examined how the authors defined climate. The papers' scale items, results, and findings were examined for evidence of climate perceptions, and study sample characteristics were evaluated for level of intersectionality. We identified nine focused organizational climates from the literature that likely play a role in the retention of engineering doctoral students: diversity, perceived cultural diversity, authenticity, psychological safety, psychosocial safety, mastery, performance, organizational support, and sexual harassment climates. We explored how power and inequality are embedded in or emphasized by those nine climates and provided guidance for future empirical work on organizational climate in engineering doctoral education to inform leadership efforts in promoting the retention of students from historically excluded groups. This paper presents a framework of nine focused climates and the perceptions captured or reflected in 23 sources representing 19 studies.

We collected initial pilot study data and reported the development procedures [8] for a multi-factor organizational climate scale to understand engineering doctoral student retention. Using an intersectional approach, we developed a scale to assess multiple focused climate factors associated with organizational commitment or member retention, many of which are particularly salient to the experiences of students from marginalized or minoritized identities. We took several steps to create the scale, including face/content validity analysis, exploratory factor analyses for validity evidence, and internal consistency for reliability evidence. The survey includes demographic items to capture the respondents' complex social identities. During the summer and fall of 2023, we collected our first pilot study data of 373 doctoral engineering students from 28 institutions in the U.S. We identified the scale's latent factor structure for construct validity evidence and evaluated internal consistency reliability evidence.

We conducted follow-up interviews with 11 engineering doctoral students with minoritized sexual identities (SMSI) to gain insight into their perceptions of the focused climates in our

framework and to identify other climates present in engineering departments. Our work employs interpretative phenomenology, meaning we reflect rather than bracket our preconceptions and work with participants to find a context that shapes a phenomenon [9], which is a constructivist approach where the researchers' assumptions and preconceived notions of a phenomenon are crucial in understanding the context under investigation [10]. Researchers' a priori knowledge and expertise are integrated with data collected about participants' lived experiences to reveal the social context of a phenomenon [9] [11]. We used our integrative climate framework to categorize themes as we coded data to ensure that the climates were relevant to SMSI, a demographic not represented in the literature. We revised several scale items and added a climate construct based on interview themes for a second pilot study.

We completed a second pilot study during the spring and summer of 2024. 477 students responded to the online survey on Qualtrics, and 288 engineering doctoral students provided valid responses on the survey. The mean age of the participants was $M = 27.73$ years ($n = 282$, $SD = 4.58$), ranging from ages 22 to 52. Students reported an average of $M = 2.84$ ($n = 282$, $SD = 1.63$) years in the doctoral program, ranging from 1 to 10 years. Exploratory factor analysis identified six latent factors with 36 items, showing excellent internal consistency reliability. However, the items for two distinct constructs for psychological safety climate and mastery climate did not group together. Therefore, we planned to revise these scale items for the next round of validity study, as the literature differentiates between these constructs.

We conducted a second round of semi-structured interviews with 16 participants during the fall of 2024. We are currently coding data from these follow-up interviews to ensure our scale items fully capture student perceptions of the climate constructs in our framework.

The finalized survey will yield actionable data for leadership to guide decisions, optimize resources, and foster a high-performing academic environment that retains students to doctoral completion.

Acknowledgement
This work was supported by the National Science Foundation under collaborative grant numbers 2201100, 2201101, 2201102, and 2201103. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation

References

[1] American Council on Education, "Achieving Diversity at the Intersection of STEM Culture and Campus Climate American Council on Education," 2019. Available: https://www.acenet.edu/Documents/Achieving-Diversity-Intersection-of-STEM-Culture-and-Campus-Climate.pdf
[2] R. M. Hall and B. R. Sandler, *The Chilly Classroom Climate: A Chilly One For Women?* Association of American Colleges, Washington, DC. Project on the Status and Education of Women., 1982.
[3] J. Hart and J. Fellabaum, "Analyzing campus climate studies: Seeking to define and understand.," *Journal of Diversity in Higher Education*, vol. 1, no. 4, pp. 222–234, 2008, doi: https://doi.org/10.1037/a0013627.
[4] American Society For Engineering Education, "Profiles of Engineering & Engineering Technology – IRA | ASEE," *ira.asee.org*, 2024. https://ira.asee.org/profiles-of-engineering-engineering-technology/
[5] H. Okahana, C. Klein, J. Allum, and R. Sowell, "STEM Doctoral Completion of Underrepresented Minority Students: Challenges and Opportunities for Improving Participation in the Doctoral Workforce," *Innovative Higher Education*, vol. 43, no. 4, pp. 237–255, Mar. 2018, doi: https://doi.org/10.1007/s10755-018-9425-3.

[6] J. L. Aldridge, N. Else-Quest, J. Roy, and S. Y. Yoon, “Engineering Doctoral Student Retention and Persistence from an Organizational Climate and Intersectional perspective: a Targeted Review of Engineering Education Literature,” presented at the ASEE Annual Conference & Exposition, Baltimore, MD, 2023.
[7] *in review*
[8] S. Y. Yoon, J. L. Aldridge, N. M. Else-Quest, and J. Roy, “Development of a Climate Survey for Engineering Doctoral Students from an Intersectional Approach: First-Round Validity Evidence,” presented at the 2024 ASEE Annual Conference & Exposition, Portland, Oregon., 2024.
[9] W. Bynum and L. Varpio, “When I say … hermeneutic phenomenology,” *Medical Education*, vol. 52, no. 3, pp. 252–253, Sep. 2017, doi: https://doi.org/10.1111/medu.13414.
[10] Henrik Gert Larsen, *Eight Domains of Phenomenology and Research Methods*. Routledge, 2023. doi: https://doi.org/10.4324/9781003270058.
[11] I. A. Urcia, “Comparisons of Adaptations in Grounded Theory and Phenomenology: Selecting the Specific Qualitative Research Methodology,” *International Journal of Qualitative Methods*, vol. 20, no. 1, pp. 1–14, 2021, doi: https://doi.org/10.1177/16094069211045474.